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PRODUCT INFORMATION

ISSUED DATE : 2011-09-19

SAMSUNG TFT-LCD PRODUCT INFORMATION

MODEL : LTM230HT10

Note : This is Product Information is subject to change after 3 months of issuing date.

Application Engineering Group

LCD Division, Samsung Electronics Co. , LTD.

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PRODUCT INFORMATION

General Description

Description

LTM230HT10 is a color active matrix liquid crystal display (LCD) that uses amorphous silicon TFT (Thin Film Transistor) as switching components. This model is composed of a TFT LCD panel, a driver circuit and a back light unit. The resolution of a 23.0" is 1920 x 1080 and this model can display up to 16.7 millions colors.

Features

- High contrast ratio, high aperture structure
- High speed response
- FHD (1920 x 1080 pixels) resolution
- White LED Edge slim Backlight (1-side)
- DE (Data Enable) only mode
- LVDS (Low Voltage Differential Signaling) interface (2pixel/clock)
- RoHS, Halogen Free
- TCO 5.2 compliance

(Except for 2.2 response time; this product does not have over driving function. It is recommended to support in system level)

Applications

- Workstation & desktop monitors
- Display terminals for AV application products
- Monitors for industrial machine

* If the module is used to other applications besides the above, please contact SEC in advance.

General Information

Items	Specification	Unit	Note
Pixel Pitch	265.50(H) x 265.50(W)	um	
Active Display Area	509.76(H) x 286.74(V)	um	
Surface Treatment	Haze 25% , Hard coating (3H)		
Display Colors	16.7M (Hi-FRC)	colors	
Number of Pixels	1,920 x 1,080	pixel	
Pixel Arrangement	RGB vertical stripe		
Display Mode	Normally White		
Luminance of White	250(Typ.)	cd/㎡	

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Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal (H)	533.5	534.0	534.5	mm	-
	Vertical (V)	311.2	311.7	312.2	mm	
	Depth (D)	-	-	10.7	mm	-
Weight		-	-	1700	g	LCD module only

Note (1) Mechanical tolerance is ± 0.5mm unless there is a special comment.

1. Absolute Maximum Ratings

If the condition exceeds maximum ratings, it can cause malfunction or unrecoverable damage to the device.

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	V_{DD}	GND-0.5	6.5	V	(1)
Data Signal	V_{sig}	-	5	V	
Storage temperature	T_{STG}	-25	60	℃	(2)
Center of Glass surface temperature (Operation)	T_{OPR}	0	50	℃	(2)
Shock (non - operating)	S_{nop}	-	50	G	(3)(5)
Vibration (non - operating)	V_{nop}	-	1.5	G	(4)(5)

Note (1) Ta= 25 ± 2 °C

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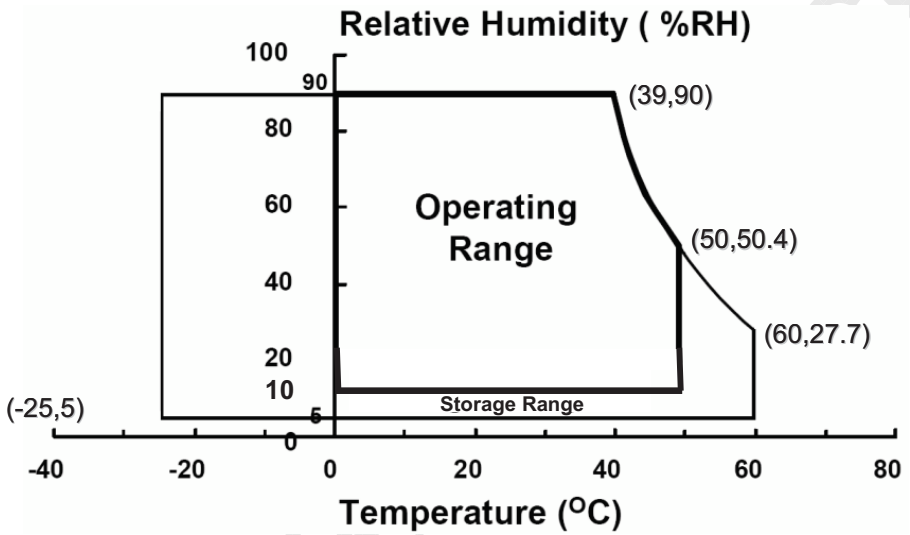
(2) Temperature and relative humidity range are shown in the figure below.
a. 90 % RH Max. (Ta ≤ 39 °C)
b. Maximum wet-bulb temperature at 39 °C or less. (Ta ≤ 39 °C)
c. No condensation
(3) 11ms, sine wave, one time for ±X, ±Y, ±Z axis
(4) 10-300 Hz, Sweep rate 10min, 30min for X,Y,Z axis
(5) At vibration and shock test, the fixture which holds the module to be tested has to be hard and rigid enough so that the module would not be twisted or bent by the fixture.



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2. Optical Characteristics

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The optical characteristics should be measured in a dark room or equivalent.
Measuring equipment : SR-3, RD-80S (TOPCON), EZ-Contrast (Eldim)

(Ta = 25 ± 2°C, VDD=5.0V, fv= 60Hz, fDCLK=67.3MHz, If =360mA)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio (Center of screen)		C/R		600	1000	-		(3) SR-3
Response Time(On/Off)		Tr		-	5	10	ms	(5) RD-80S
		Tf						
Luminance of White (Center of screen)		Y_L		200	250	-	cd/m^2	(6) SR-3
Color Chromaticity (CIE 1931)	Red	Rx	Normal $\theta_{L,R}=0$ $\theta_{U,D}=0$ Viewing Angle	-0.030	0.633	+0.030		(7),(8) SR-3
		Ry			0.340			
	Green	Gx			0.320			
		Gy			0.622			
	Blue	Bx			0.155			
		By			0.042			
	White	Wx			0.313			
		Wy			0.329			
Color Chromaticity (CIE 1976)	Red	Ru'		-	0.443	-		
		Rv'		-	0.527	-		
	Green	Gu'		-	0.131	-		
		Gv'		-	0.569	-		
	Blue	Bu'		-	0.189	-		
		Bv'		-	0.125	-		
	White	Wu'		-	0.198	-		
		Wv'		-	0.468	-		
C.G.L (ACC ONLY)	White	△u'v'		-	-	0.02		(9)

* C.G.L : Color Grayscale Linearity

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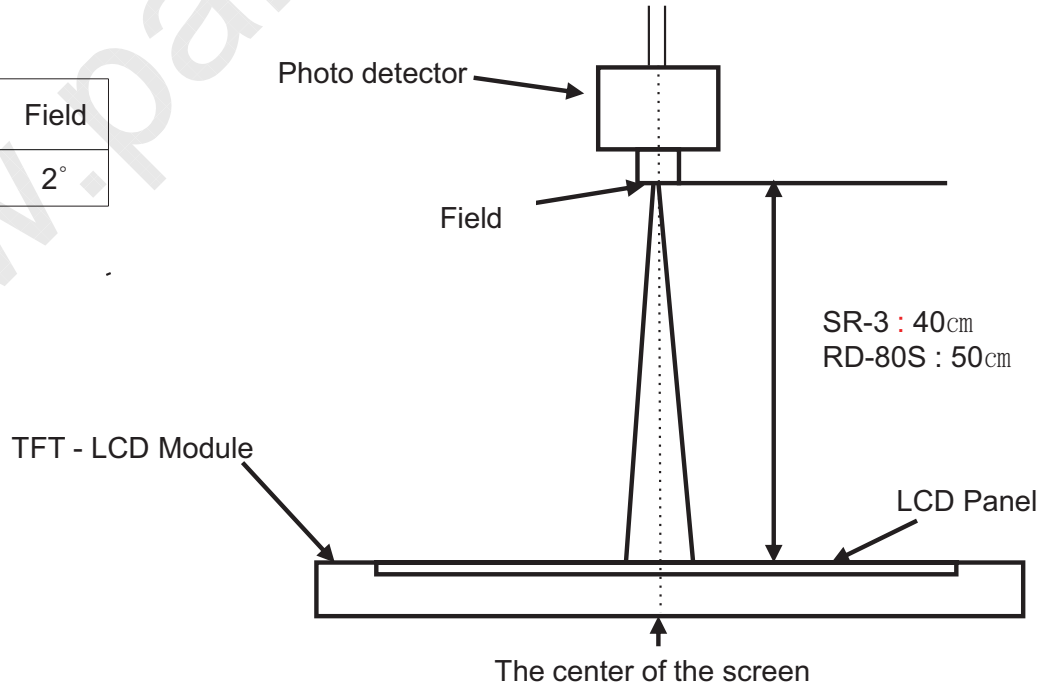
Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Color Gamut		-		-	72	-	%	
Color Temperature		-		-	6500	-	K	
Viewing Angle	Hor.	θ_L	CR≥10	70	80	-	Degrees	(8) EZ-Contrast
		θ_R		70	80	-		
	Ver.	θ_U		70	80	-		
		θ_D		70	80	-		
Brightness Uniformity (9 Points)		B_{uni}		-	-	25	%	(4) SR-3

Note (1) Test Equipment Setup

The measurement should be executed in a stable, windless and dark room between 30min after lighting the back light at the given temperature for stabilization of the back light. This should be measured in the center of screen.

LED Forward current : If = 360 mA Environment condition : Ta = 25 ± 2 °C

Photo detector	Field
SR-3	2°



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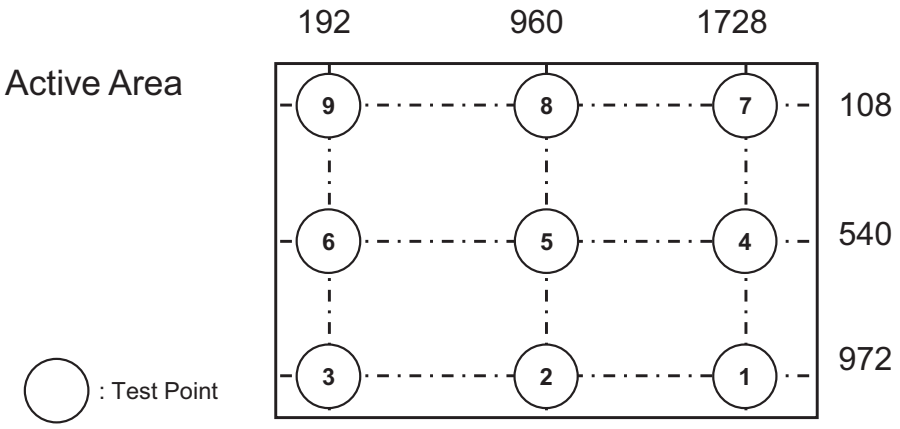
Note (2) Definition of test point



Note (3) Definition of Contrast Ratio (C/R)
: Ratio of gray max (Gmax) & gray min (Gmin) at the center point⑤ of the panel

$$CR = \frac{G\max}{G\min}$$

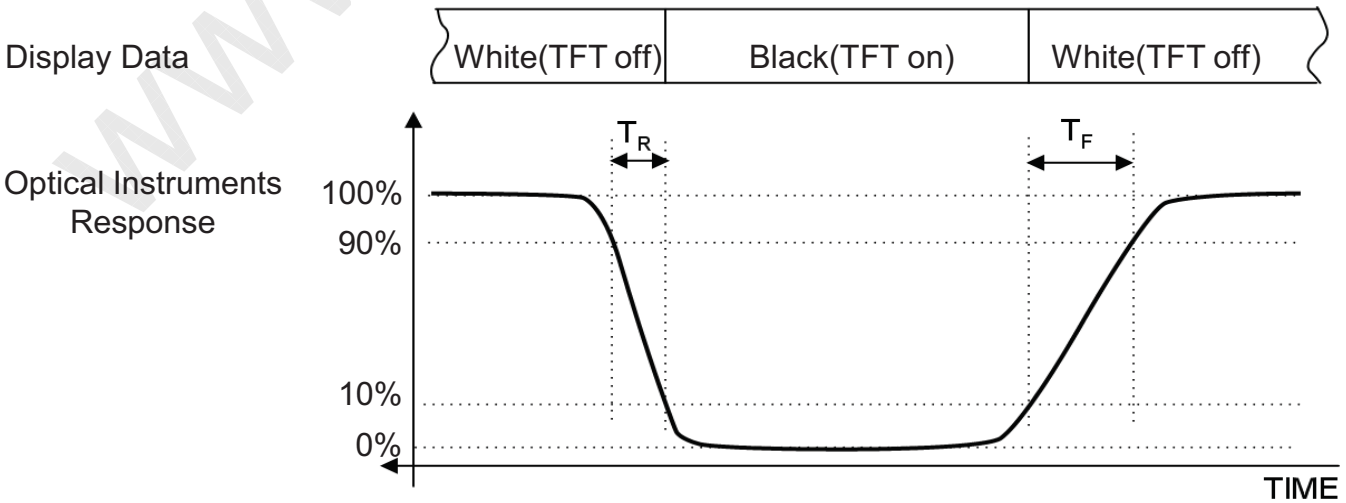
Gmax : Luminance with all pixels white
Gmin : Luminance with all pixels black

Note (4) Definition of 9 points brightness uniformity

$$Buni = 100 \times \frac{(B\max - B\min)}{B\max}$$

Bmax : Maximum brightness
Bmin : Minimum brightness

Note (5) Definition of Response time : Sum of Tr, Tf



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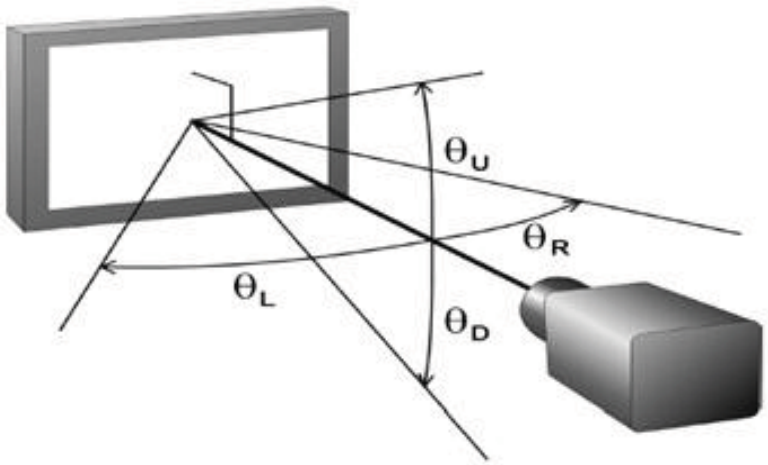
Note (6) Definition of Luminance of White : Luminance of white at center point⑤

Note (7) Definition of Color Chromaticity (CIE 1931, CIE1976)
Color coordinate of Red, Green, Blue & White at center point⑤

Note (8) Definition of Viewing Angle
: Viewing angle range (CR ≥ 10)



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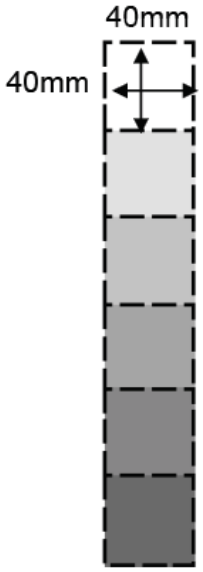
Note (9) Color Grayscale Linearity

a. Test image : 100% full white pattern with a test pattern as below

b. Test pattern : Squares, 40mm by 40mm in size, filled with 255, 225, 195, 165, 135 and 105 grays steps should be arranged at the center⑤ of the screen.



c. Test method

-1st gray step : move a square of 255 gray level should be moved into the center of the screen and measure luminance and u' and v' coordinates.

- Next gray step : Move a 225 gray square into the center and measure both luminance and coordinates, too.

d. Test evaluation

$$\Delta u'v' = \sqrt{(u'_A - u'_B)^2 + (v'_A - v'_B)^2}$$

Where A, B : 2 gray levels found to have the largest color differences between them

i.e. get the largest Δu' and Δv' of each 6 pair of u' and v' and calculate the Δu'v'.

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3. Electrical Characteristics

3.1 TFT LCD Module

The connector for display data & timing signal should be connected.

Ta = 25°C

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V_{DD}	4.5	5.0	5.5	V	(1)
LVDS Input Characteristics	Differential Input Voltage for LVDS receiver threshold	High			+100	mV	(2)
		Low	-100			mV	
	LVDS skew	T skew	-270		270	Ps	(3)
	Differential input voltage	lVidl	100		600	mV	(4)
	Input voltage range(single ended)	Vin	0.7		1.7	V	(4)
	Common mode voltage	Vcm	1.0	1.2	1.4	V	(4)
Current of Power Supply	(a) Black	I_{DD}	-	1,200	-	mA	(5),(6)
	(b) White		-	700	-	mA	
	(c) Dot		-	1,300	1,500	mA	
Vsync Frequency		f_V	49.0	60.0	77.0	Hz	
Hsync Frequency		f_H	54.0	66.0	88.0	kHz	
Main Frequency		f_{DCLK}	55.3	67.3	87.5	MHz	
Rush Current		I_{RUSH}	-	-	5.0	A	(7)

Note (1) The ripple voltage should be controlled under 10% of V_{DD}.

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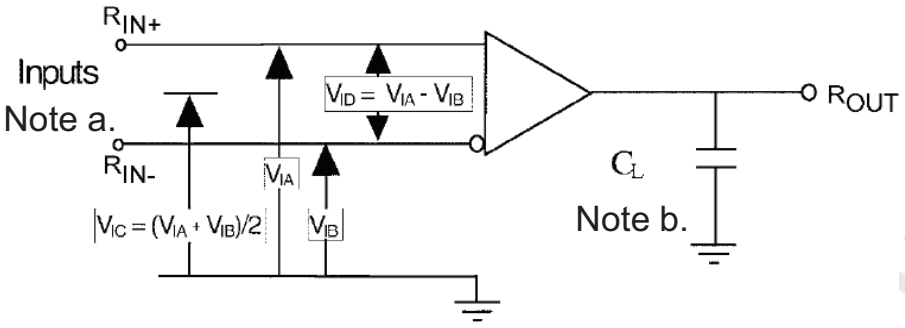
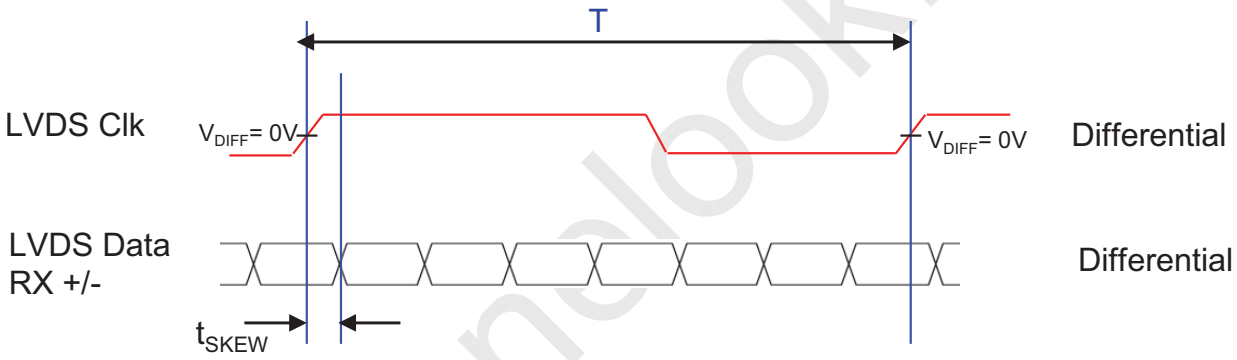
(2) Differential receiver voltage definitions and propagation delay and transition time test circuit

a. All input pulses have frequency = 10MHz, t_R or t_F=1ns

b. C_L includes all probe and fixture capacitance



(3) LVDS Receiver DC parameters are measured under static and steady conditions which may not be reflective of its performance in the end application.

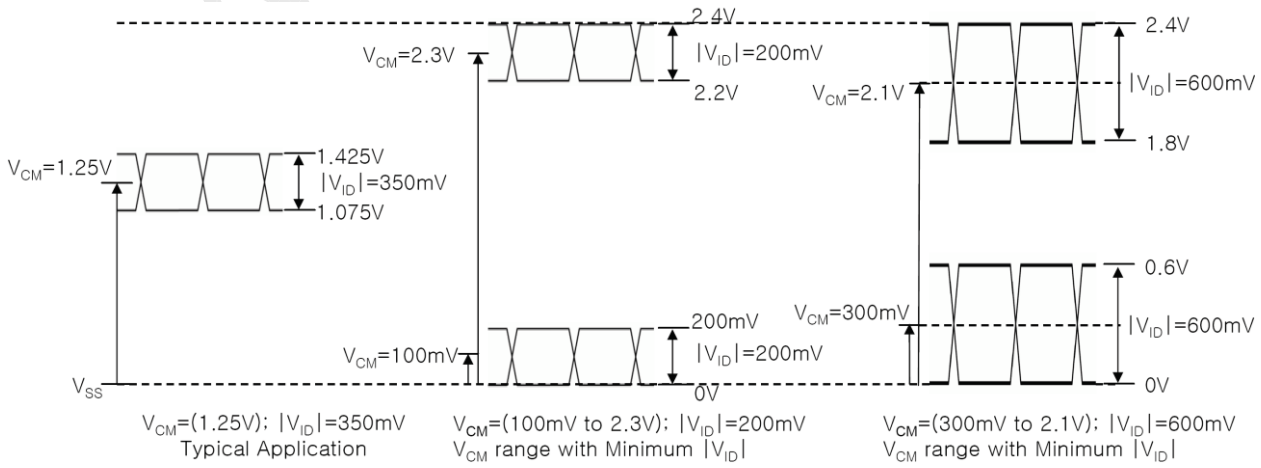


where tskew : skew between LVDS clock & LVDS data,

T : 1 period time of LVDS clock

cf) (-/+) of 300psec means LVDS data goes before or after LVDS clock.

(4) Definition of V_{ID} and V_{CM} using single-end signals



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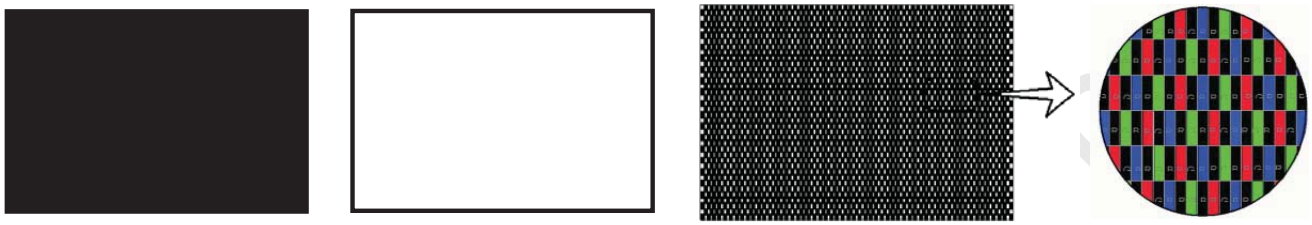
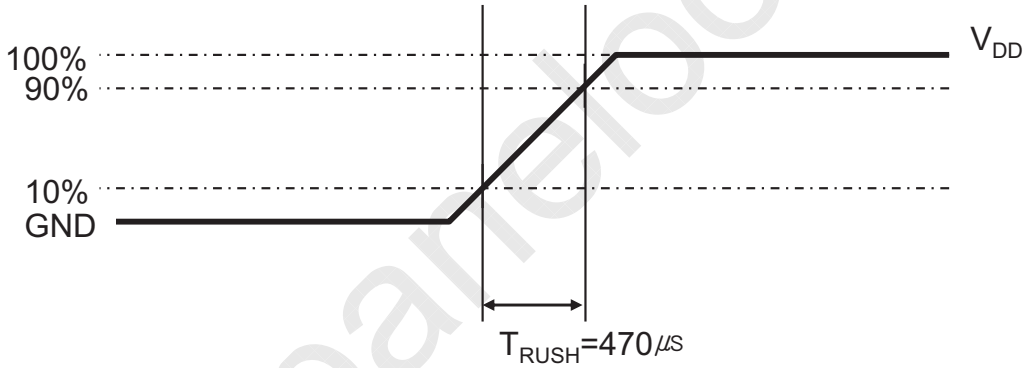
(5) fV=60Hz, fDCLK = 67.3MHz, VDD = 5.0V, DC Current.

(6) Power dissipation check pattern (LCD Module only)

a) Black Pattern b) White Pattern c) Dot Pattern



(7) Measurement Condition



Rush Current I_{RUSH} can be measured when T_{RUSH}. is 470μs.

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3.2 Back Light Unit

3.2.1 The characteristics of LED bar

The back light unit is composed of WLED.

Ta=25 ± 2°C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
LED Forward Current	I_F	-	120	125	mA	(1)
LED Array Voltage	V_P	-	35.2	37.4	V	-
Operating Life Time	Hr	30,000	-	-	Hour	(2)

Note (1) The above specification is not for the converter output, but for the LED bar.
The LED bar consists of 33 LED packages ; 3parallel X 11 serial

(2) Life time (Hr) is defined as the time when brightness of a LED package itself becomes 50% or less than its original value at the condition of Ta=25 ± 2°C and I_F =360mA.

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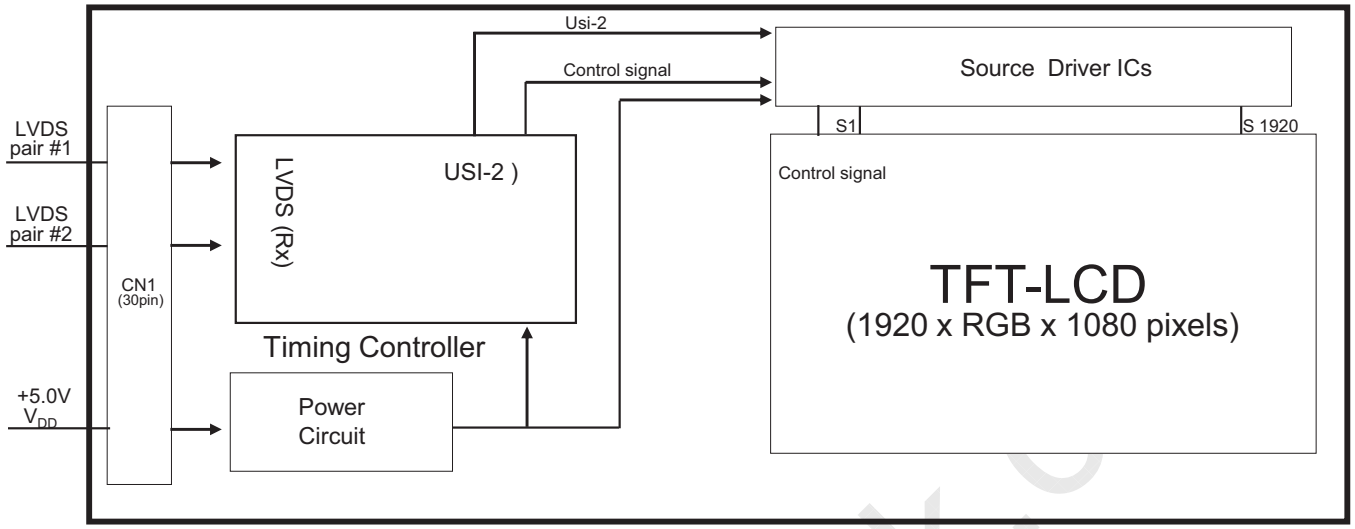
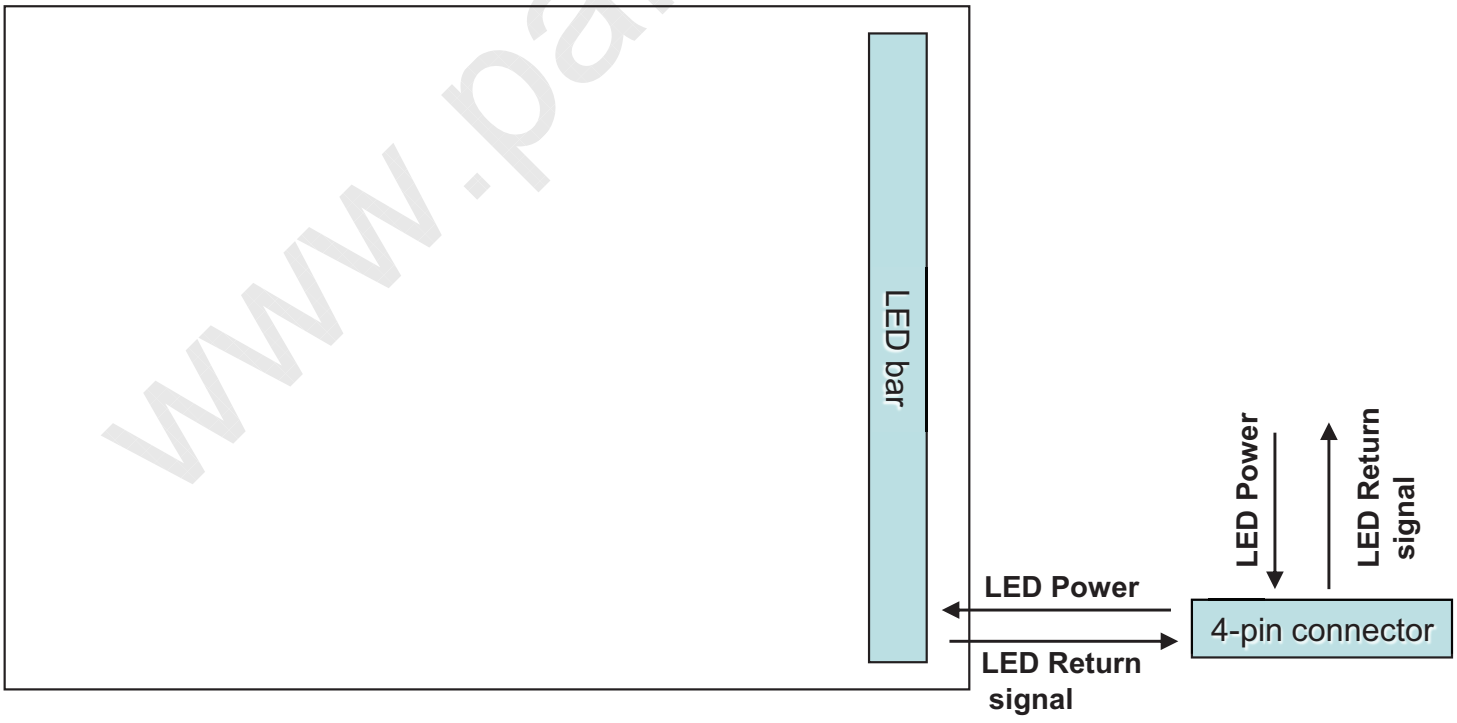
4. BLOCK DIAGRAM

4.1 TFT LCD Module



4.2 Back Light Unit

Connector: Molex 104086-0410
((Matching Connector : Molex 104085-0400)



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5. Input Terminal Pin Assignment

5.1. Input Signal & Power (Connector : P-TWO 196260-30041 or equivalent)

PIN NO	SYMBOL	FUNCTION
1	RXO0N	Negative LVDS differential data output
2	RXO0P	Positive LVDS differential data output
3	RXO1N	Negative LVDS differential data output
4	RXO1P	Positive LVDS differential data output
5	RXO2N	Negative LVDS differential data output
6	RXO2P	Positive LVDS differential data output
7	GND	Ground
8	RXOC-	Negative Sampling Clock (ODD data)
9	RXOC+	Positive Sampling Clock (ODD data)
10	RXO3N	Negative LVDS differential data output
11	RXO3P	Positive LVDS differential data output
12	RXE0N	Negative LVDS differential data output
13	RXE0P	Positive LVDS differential data output
14	GND	Ground
15	RXE1N	Negative LVDS differential data output
16	RXE1P	Positive LVDS differential data output
17	GND	Ground
18	RXE2N	Negative LVDS differential data output
19	RXE2P	Positive LVDS differential data output
20	RXEC-	Negative Sampling Clock (EVEN data)
21	RXEC+	Positive Sampling Clock (EVEN data)
22	RXE3N	Negative LVDS differential data output
23	RXE3P	Positive LVDS differential data output
24	GND	Ground
25	NC	* CE (For LCD internal use only. Do not connect)
26	NC	* CTL (For LCD internal use only. Do not connect)
27	NC	No Connection
28	VDD	Power Supply : +5V
29	VDD	
30	VDD	

* If the system already uses the 25, 26pins, it should keep under GND level
The voltage applied to those pins should not exceed -200mV.

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Note) Pin number starts from Left side

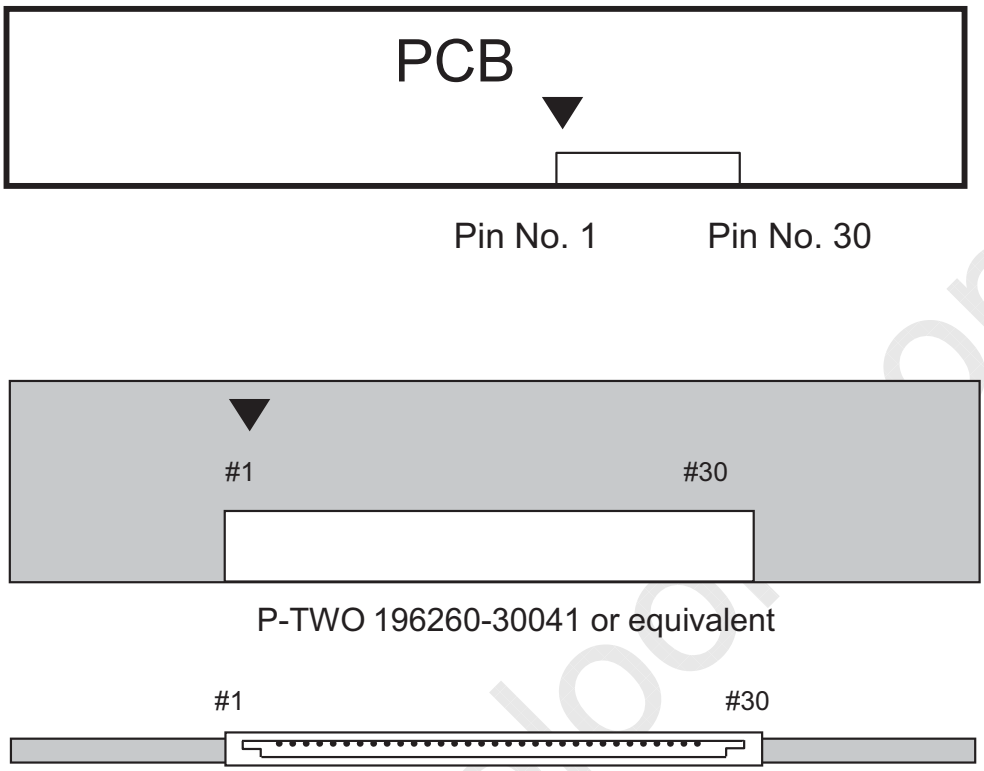

Fig. Connector diagram

a. All GND pins should be connected together and also be connected to the LCD's metal chassis.
b. All power input pins should be connected together.
c. All NC pins should be separated from other signal or power.

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5.2 LVDS Interface (1)

5.2.1 Odd Pixel Data (1st pixel data)

LVDS Transmitter (**DS90C387**) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM230HT10 Interface (CN1)	
No	Symbol	Symbol	Function		Terminal	Symbol
51	TXIN0	RO0	Red Odd Pixel Data (LSB)	TXOUT0- TXOUT0+	No. 1 No. 2	RXO0- RXO0+
52	TXIN1	RO1	Red Odd Pixel Data			
54	TXIN2	RO2	Red Odd Pixel Data			
55	TXIN3	RO3	Red Odd Pixel Data			
56	TXIN4	RO4	Red Odd Pixel Data			
2	TXIN5	RO7	Red Odd Pixel Data (MSB)	TXOUT3- TXOUT3+	No. 10 No. 11	RXO3- RXO3+
3	TXIN6	RO5	Red Odd Pixel Data	TXOUT0- TXOUT0+	No. 1 No. 2	RXO0- RXO0+
4	TXIN7	GO0	Green Odd Pixel Data (LSB)			
6	TXIN8	GO1	Green Odd Pixel Data	TXOUT1- TXOUT1+	No. 3 No. 4	RXO1- RXO1+
7	TXIN9	GO2	Green Odd Pixel Data			
8	TXIN10	GO6	Green Odd Pixel Data	TXOUT3- TXOUT3+	No. 10 No. 11	RXO3- RXO3+
10	TXIN11	GO7	Green Odd Pixel Data (MSB)			
11	TXIN12	GO3	Green Odd Pixel Data	TXOUT1- TXOUT1+	No. 3 No. 4	RXO1- RXO1+
12	TXIN13	GO4	Green Odd Pixel Data			
14	TXIN14	GO5	Green Odd Pixel Data			
15	TXIN15	BO0	Blue Odd Pixel Data (LSB)			
16	TXIN16	BO6	Blue Odd Pixel Data	TXOUT3- TXOUT3+	No. 10 No. 11	RXO3- RXO3+
18	TXIN17	BO7	Blue Odd Pixel Data (MSB)			
19	TXIN18	BO1	Blue Odd Pixel Data	TXOUT1- TXOUT1+	No. 3 No. 4	RXO1- RXO1+
20	TXIN19	BO2	Blue Odd Pixel Data	TXOUT2- TXOUT2+	No. 5 No. 6	RXO2- RXO2+
22	TXIN20	BO3	Blue Odd Pixel Data			
23	TXIN21	BO4	Blue Odd Pixel Data			
24	TXIN22	BO5	Blue Odd Pixel Data			
50	TXIN27	RO6	Red Odd Pixel Data	TXOUT3- TXOUT3+	No. 10 No. 11	RXO3- RXO3+

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5.2.2 Even Pixel Data (2nd pixel data)

LVDS Transmitter (**DS90C387**) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM230HT10 Interface (CN1)	
No	Symbol	Symbol	Function		Terminal	Symbol
51	TXIN0	RE0	Red Even Pixel Data (LSB)	TXOUT0- TXOUT0+	No. 12 No. 13	RXE0- RXE0+
52	TXIN1	RE1	Red Even Pixel Data			
54	TXIN2	RE2	Red Even Pixel Data			
55	TXIN3	RE3	Red Even Pixel Data			
56	TXIN4	RE4	Red Even Pixel Data			
2	TXIN5	RE7	Red Even Pixel Data (MSB)	TXOUT3- TXOUT3+	No. 22 No. 23	RXE3- RXE3+
3	TXIN6	RE5	Red Even Pixel Data	TXOUT0- TXOUT0+	No. 12 No. 13	RXE0- RXE0+
4	TXIN7	GE0	Green Even Pixel Data (LSB)			
6	TXIN8	GE1	Green Even Pixel Data	TXOUT1- TXOUT1+	No. 15 No. 16	RXE1- RXE1+
7	TXIN9	GE2	Green Even Pixel Data			
8	TXIN10	GE6	Green Even Pixel Data	TXOUT3- TXOUT3+	No. 22 No. 23	RXE3- RXE3+
10	TXIN11	GE7	Green Even Pixel Data (MSB)			
11	TXIN12	GE3	Green Even Pixel Data	TXOUT1- TXOUT1+	No. 15 No. 16	RXE1- RXE1+
12	TXIN13	GE4	Green Even Pixel Data			
14	TXIN14	GE5	Green Even Pixel Data			
15	TXIN15	BE0	Blue Even Pixel Data (LSB)			
16	TXIN16	BE6	Blue Even Pixel Data	TXOUT3- TXOUT3+	No. 22 No. 23	RXE3- RXE3+
18	TXIN17	BE7	Blue Even Pixel Data (MSB)			
19	TXIN18	BE1	Blue Even Pixel Data	TXOUT1- TXOUT1+	No. 15 No. 16	RXE1- RXE1+
20	TXIN19	BE2	Blue Even Pixel Data	TXOUT2- TXOUT2+	No. 18 No. 19	RXE2- RXE2+
22	TXIN20	BE3	Blue Even Pixel Data			
23	TXIN21	BE4	Blue Even Pixel Data			
24	TXIN22	BE5	Blue Even Pixel Data			
50	TXIN27	RE6	Red Even Pixel Data	TXOUT3- TXOUT3+	No. 22 No. 23	RXE3- RXE3+

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5.2 LVDS Interface (2)

5.2.3 Odd Pixel Data (1st pixel data)

LVDS Transmitter (**DS90C387**) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM230HT10 Interface (CN1)	
No	Symbol	Symbol	Function		Terminal	Symbol
10	R10	RO0	Red Odd Pixel Data (LSB)	A0M A0P	No. 1 No. 2	RXO0- RXO0+
9	R11	RO1	Red Odd Pixel Data			
8	R12	RO2	Red Odd Pixel Data			
7	R13	RO3	Red Odd Pixel Data			
6	R14	RO4	Red Odd Pixel Data			
3	R17	RO7	Red Odd Pixel Data (MSB)	A3M A3P	No. 10 No. 11	RXO3- RXO3+
5	R15	RO5	Red Odd Pixel Data	A0M A0P	No. 1 No. 2	RXO0- RXO0+
2	G10	GO0	Green Odd Pixel Data (LSB)			
1	G11	GO1	Green Odd Pixel Data	A1M A1P	No. 3 No. 4	RXO1- RXO1+
100	G12	GO2	Green Odd Pixel Data			
94	G16	GO6	Green Odd Pixel Data	A3M A3P	No. 10 No. 11	RXO3- RXO3+
93	G17	GO7	Green Odd Pixel Data (MSB)			
99	G13	GO3	Green Odd Pixel Data	A1M A1P	No. 3 No. 4	RXO1- RXO1+
96	G14	GO4	Green Odd Pixel Data			
95	G15	GO5	Green Odd Pixel Data			
92	B10	BO0	Blue Odd Pixel Data (LSB)			
86	B16	BO6	Blue Odd Pixel Data	A3M A3P	No. 10 No. 11	RXO3- RXO3+
85	B17	BO7	Blue Odd Pixel Data (MSB)			
91	B11	BO1	Blue Odd Pixel Data	A1M A1P	No. 3 No. 4	RXO1- RXO1+
90	B12	BO2	Blue Odd Pixel Data	A2M A2P	No. 5 No. 6	RXO2- RXO2+
89	B13	BO3	Blue Odd Pixel Data			
88	B14	BO4	Blue Odd Pixel Data			
87	B15	BO5	Blue Odd Pixel Data			
4	R16	RO6	Red Odd Pixel Data	A3M A3P	No. 10 No. 11	RXO3- RXO3+

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5.2.4 Even Pixel Data (2nd pixel data)

LVDS Transmitter (**DS90C387**) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM230HT10 Interface (CN1)	
No	Symbol	Symbol	Function		Terminal	Symbol
84	R20	RE0	Red Even Pixel Data (LSB)	A4M A4P	No. 12 No. 13	RXE0- RXE0+
81	R21	RE1	Red Even Pixel Data			
80	R22	RE2	Red Even Pixel Data			
79	R23	RE3	Red Even Pixel Data			
78	R24	RE4	Red Even Pixel Data			
75	R27	RE7	Red Even Pixel Data (MSB)	A7M A7P	No. 22 No. 23	RXE3- RXE3+
77	R25	RE5	Red Even Pixel Data	A4M A4P	No. 12 No. 13	RXE0- RXE0+
74	G20	GE0	Green Even Pixel Data (LSB)			
73	G21	GE1	Green Even Pixel Data	A5M A5P	No. 15 No. 16	RXE1- RXE1+
72	G22	GE2	Green Even Pixel Data			
66	G26	GE6	Green Even Pixel Data	A7M A7P	No. 22 No. 23	RXE3- RXE3+
65	G27	GE7	Green Even Pixel Data (MSB)			
71	G23	GE3	Green Even Pixel Data	A5M A5P	No. 15 No. 16	RXE1- RXE1+
70	G24	GE4	Green Even Pixel Data			
69	G25	GE5	Green Even Pixel Data			
64	B20	BE0	Blue Even Pixel Data (LSB)			
58	B26	BE6	Blue Even Pixel Data	A7M A7P	No. 22 No. 23	RXE3- RXE3+
57	B27	BE7	Blue Even Pixel Data (MSB)			
63	B21	BE1	Blue Even Pixel Data	A5M A5P	No. 15 No. 16	RXE1- RXE1+
62	B22	BE2	Blue Even Pixel Data	A6M A6P	No. 18 No. 19	RXE2- RXE2+
61	B23	BE3	Blue Even Pixel Data			
60	B24	BE4	Blue Even Pixel Data			
59	B25	BE5	Blue Even Pixel Data			
76	R26	RE6	Red Even Pixel Data	A7M A7P	No. 22 No. 23	RXE3- RXE3+

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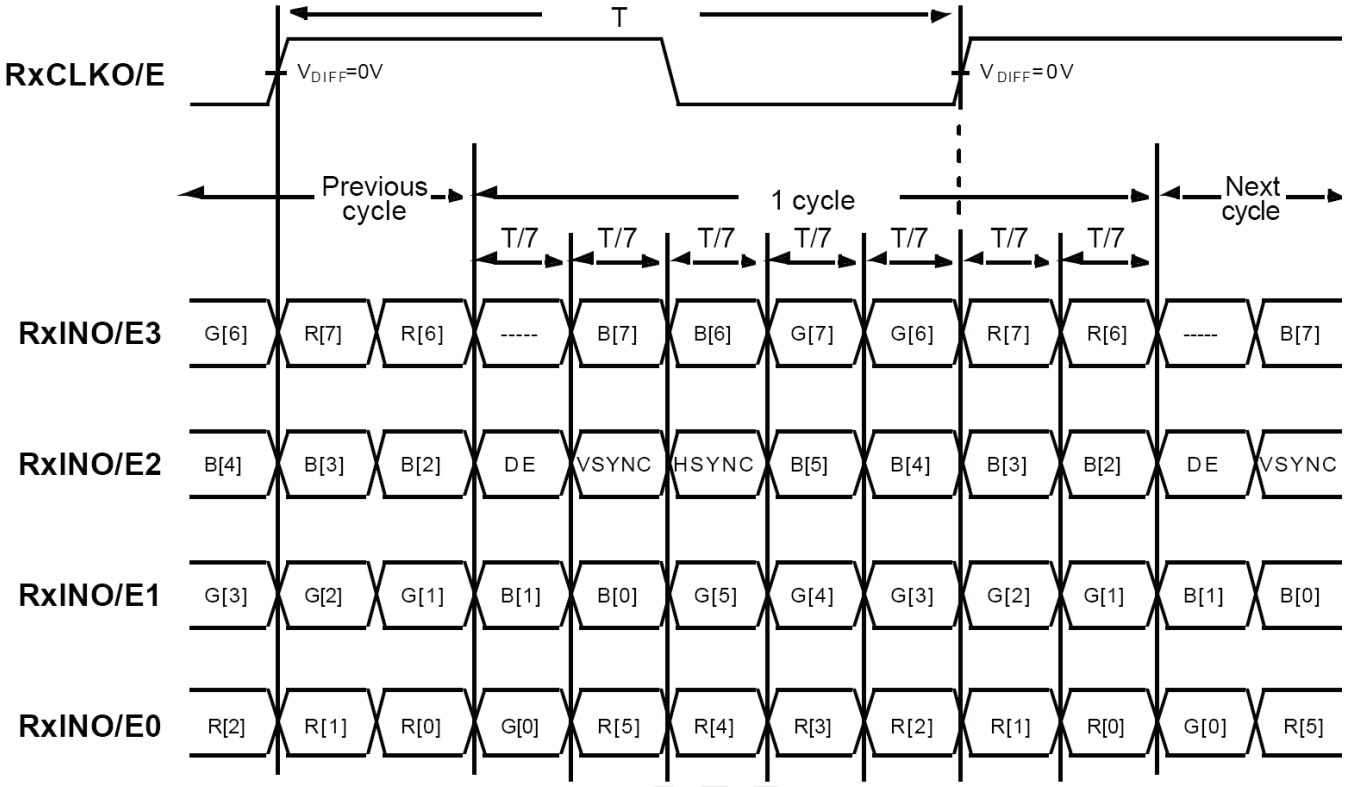
5.2.5 Timing Diagrams of LVDS For Transmitting

LVDS Receiver : Integrated T-CON



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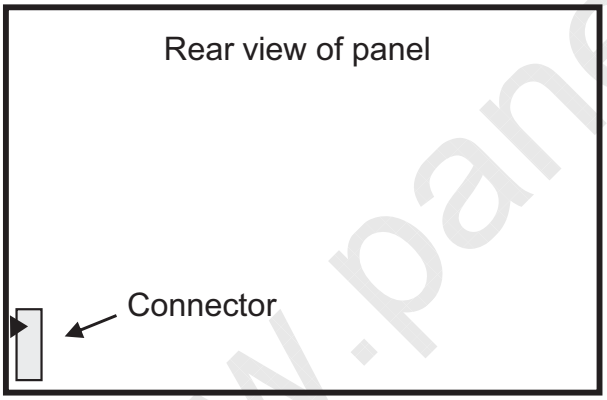
5.3 Back Light Unit

LED Bar input connector :

Connector: Molex 104086-0410
((Matching Connector : Molex 104085-0400 or equivalent)

Pin No.	Pin description	Function
1	Vin	LED power input
2	RTN 1	Channel 1 LED return
3	RTN 2	Channel 2 LED return
4	RTN 3	Channel 3 LED return

Note) Pin number starts from Left side



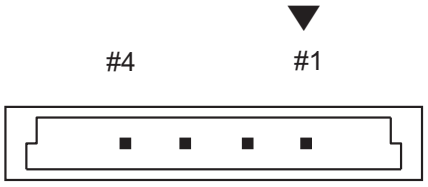


Fig. Connector diagram

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5.4 Input Signals, Basic Display Colors and Gray Scale of Each Color

COLOR	DISPLAY (8bit)	DATA SIGNAL																								GRAY SCALE LEVEL
		RED								GREEN								BLUE								
		R0	R1	R2	R3	R4	R5	R6	R7	G0	G1	G2	G3	G4	G5	G6	G7	B0	B1	B2	B3	B4	B5	B6	B7	
BASIC COLOR	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	-
	GREEN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	-
	CYAN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
	RED	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
	MAGENTA	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	-
	YELLOW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	-
	WHITE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
GRAY SCALE OF RED	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R0
	DARK ↑	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R1
		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R2
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			R3~ R252
	↓ LIGHT	:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			
		1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R253
		0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R254
	RED	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R255
GRAY SCALE OF GREEN	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G0
	DARK ↑	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G1
		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G2
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			G3~ G252
	↓ LIGHT	:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			
		0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	G253
		0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	G254
	GREEN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	G255
GRAY SCALE OF BLUE	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	B0
	DARK ↑	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	B1
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	B2
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			B3~ B252
	↓ LIGHT	:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	B253
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	B254
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	B255

Note (1) Definition of Gray :

Rn : Red Gray, Gn : Green Gray, Bn : Blue Gray (n = Gray level)

Input Signal : 0 = Low level voltage, 1 = High level voltage

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6. Interface Timing

6.1 Timing Parameters (DE only mode)

SIGNAL	ITEM	SYMBOL	MIN.	TYP.	MAX.	Unit	NOTE
Clock	Frequency	$1/T_C$	55.3	67.3	87.5	MHz	-
Hsync		F_H	54.0	66.0	88.0	kHz	-
Vsync		F_V	49	60	77	Hz	-
Vertical Display Term	Active Display Period	T_{VD}	1080	1080	1080	Lines	-
	Vertical Total	T_V	1090	1111	1250	Lines	-
Horizontal Display Term	Active Display Period	T_{HD}	960	960	960	Clocks	2pixel/ clock
	Horizontal Total	T_H	990	1010	1040	clocks	2pixel/ clock

Note (1) Test Point : TTL control signal and CLK at LVDS Tx input terminal in system

(2) Internal Vcc = 5.0V

(3) While operation, DE signal should be have the same cycle.

(4) Main frequency Max is 87.5MHz without spread spectrum.

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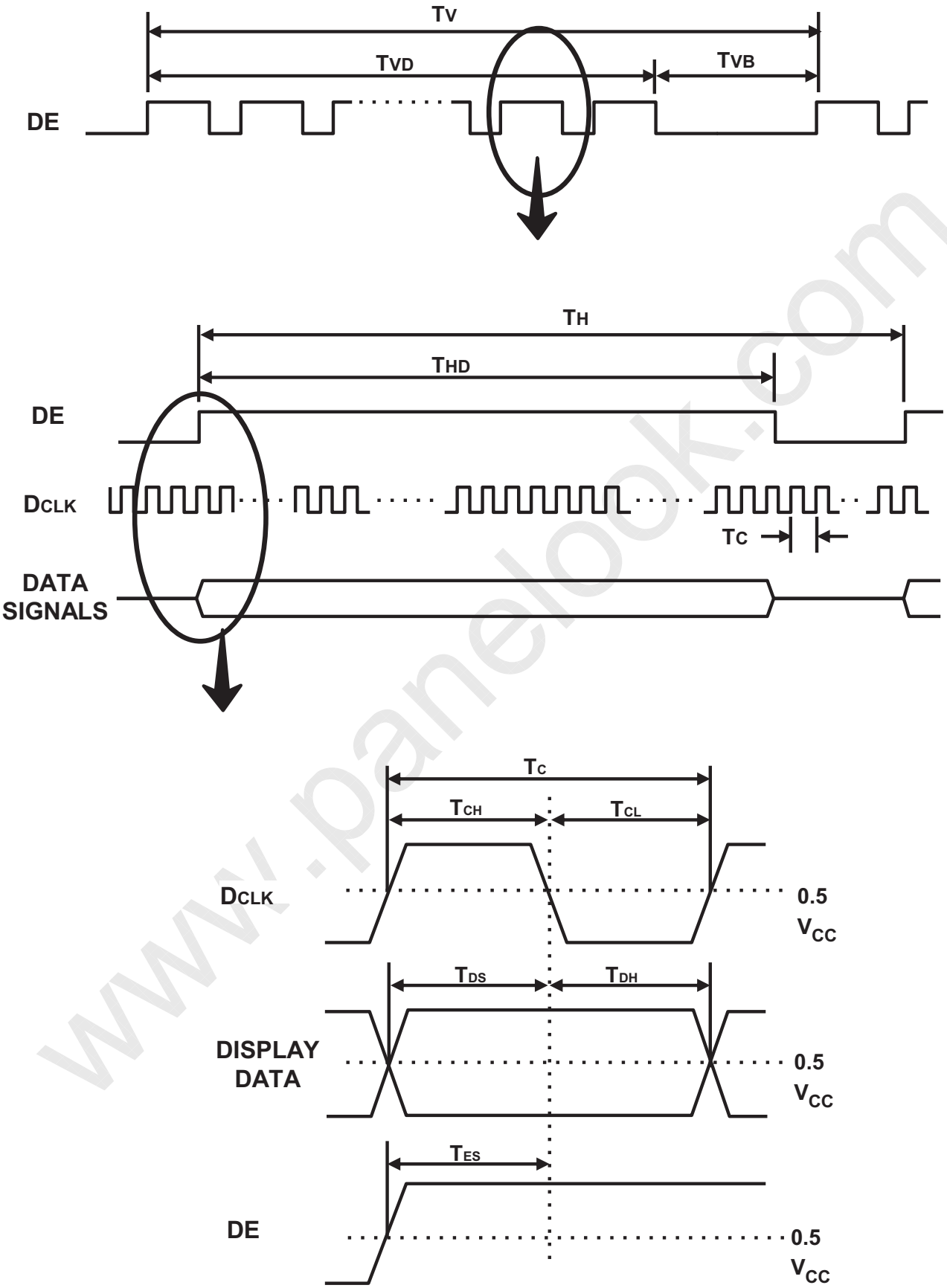
6.2 Timing diagrams of interface signal (DE only mode)



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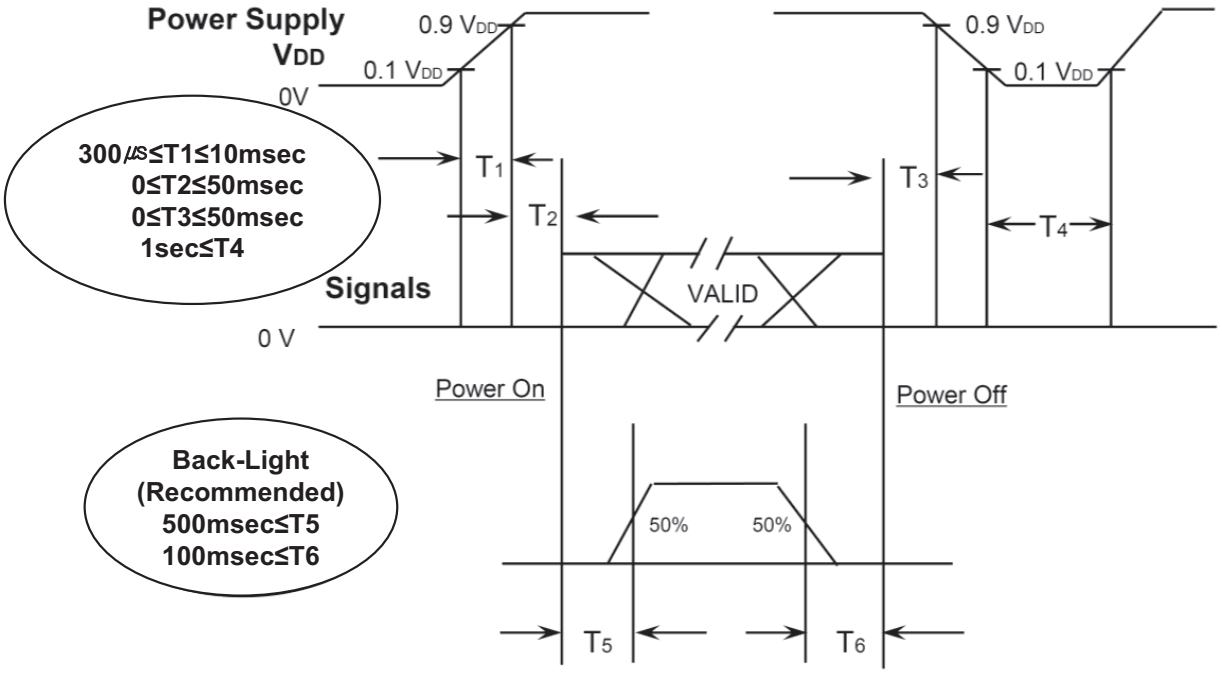
6.3 Power ON/OFF Sequence

To prevent a latch-up or DC operation of the LCD Module, the power on/off sequence should be as the diagram below.



T1 : V_{DD} rising time from 10% to 90%
T2 : The time from V_{DD} to valid data at power ON.
T3 : The time from valid data off to V_{DD} off at power Off.
T4 : V_{DD} off time for Windows restart
T5 : The time from valid data to B/L enable at power ON.
T6 : The time from valid data off to B/L disable at power Off.

- The supply voltage of the external system for the Module input should be the same as the definition of V_{DD}.
- Apply the lamp voltage within the LCD operation range. When the back light turns on before the LCD operation or the LCD turns off before the back light turns off, the display may momentarily show abnormal screen.
- In case of V_{DD} = off level, please keep the level of input signals low or keep a high impedance.
- T4 should be measured after the Module has been fully discharged between power off and on period.
- Interface signal should not be kept at high impedance when the power is on.

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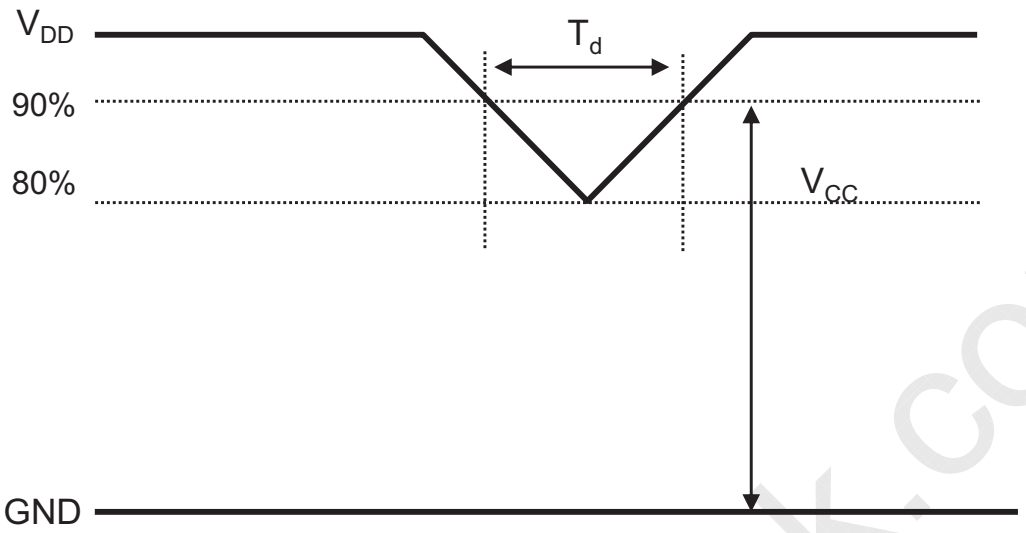
6.4 VDD Power Dip Condition



$4.5V \le V_{DD} \le 5.5V$
If V_{DD}(typ.) x 80% $\le V_{CC} \le V_{DD}$(typ) x 90%
Then, 0<Td ≤20msec

Note (1) The above conditions are for the glitch of the input voltage.
(2) For stable operation of an LCD Module power, please follow them.
i.e., if typ VDD x 80% ≤ Vcc ≤ typ VDD x 90%, then T_d should be less than 20ms.

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7. Outline Dimension

[Refer to the next page]

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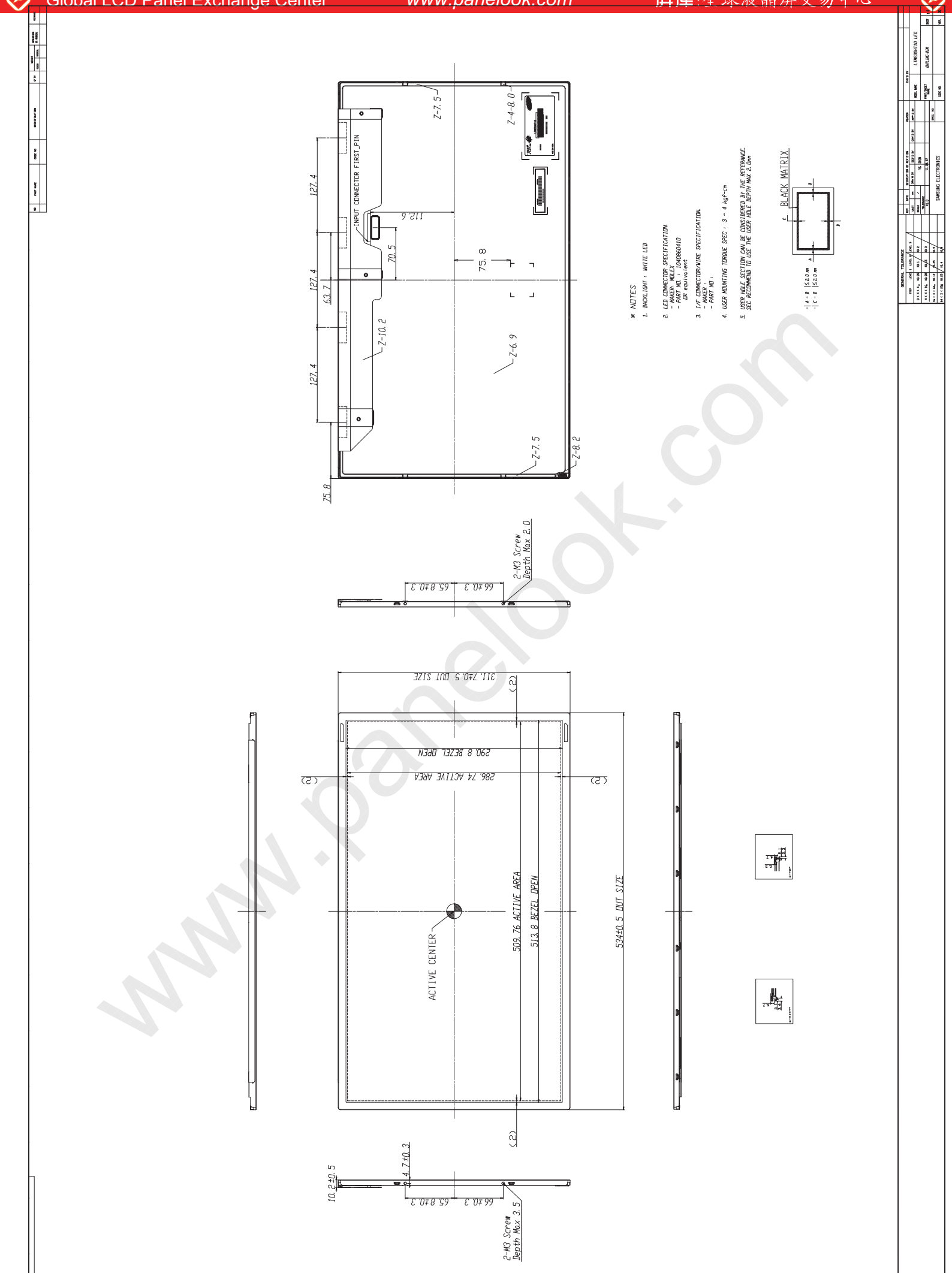

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8. General Precautions

8.1 Handling

(a) When the module is assembled, it should be attached to the system firmly using all mounting holes. Be careful not to twist and bend the module.

(b) Refrain from strong mechanical shock and / or any force to the module. In addition to damage, it may cause improper operation or damage to the module and LED back light.

(c) Note that polarizer films are very fragile and could be damaged easily. Do not press or scratch the surface harder than a HB pencil lead.

(d) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, staining or discoloration may occur.

(e) If the surface of the polarizer is dirty, clean it using absorbent cotton or soft cloth.

(f) Desirable cleaners are water, IPA (Isopropyl Alcohol) or Hexane. Do not use Ketone type materials (ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might cause permanent damage to the polarizer due to chemical reaction.

(g) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth . In case of contact with hands, legs or clothes, it must be washed away with soap thoroughly.

(h) Protect the Module from static, or the CMOS Gate Array IC would be damaged.

(i) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.

(j) Do not disassemble the Module.

(k) Protection film for polarizer on the Module should be slowly peeled off just before use so that the electrostatic charge can be minimized.

(l) Pins of I/F connector should not be touched directly with bare hands.

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8.2 Storage

We highly recommend to comply with the criteria in the table below

ITEM	Unit	Min.	Max.
Storage Temperature	(℃)	5	40
Storage Humidity	(%rH)	35	75
Storage life	12 months		
Storage Condition	- The storage room should provide good ventilation and temperature control. - Products should not be placed on the floor, but on the Pallet away from a wall. - Prevent products from direct sunlight, moisture nor water; Be cautious of a build up of condensation. - Avoid other hazardous environment while storing goods. - If products delivered or kept in conditions of over the storage period of 3 months, the recommended temperature or humidity range, we recommend you leave them at a temperature of 20℃ and a humidity of 50% for 24 hours.		

8.3 Operation

(a) Do not connect or disconnect the Module in the "Power On" condition.

(b) Power supply should always be turned on/off by the item 6.3 "Power on/off sequence"

(c) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference should be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.

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8.4 Operation Condition Guide

(a) The LCD product should be operated under normal conditions.
Normal condition is defined as below;
- Temperature : 20±15℃
- Humidity : 65±20%
- Display pattern : continually changing pattern (Not stationary)

(b) If the product will be used in extreme conditions such as high temperature, humidity, display patterns or operation time etc.., It is strongly recommended to contact SEC for Application engineering advice. Otherwise, its reliability and function may not be guaranteed. Extreme conditions are commonly found at Airports, Transit Stations, Banks, Stock market, and Controlling systems.

8.5 Others

(a) Ultra-violet ray filter is necessary for outdoor operation.

(b) Avoid condensation of water. It may result in improper operation or disconnection of electrode.

(c) Do not exceed the absolute maximum rating value. (supply voltage variation, input voltage variation, variation in part contents and environmental temperature, and so on)
Otherwise the Module may be damaged.

(d) If the Module keeps displaying the same pattern for a long period of time, the image may be "sticked" to the screen.
To avoid image sticking, it is recommended to use a screen saver.

(e) This Module has its circuitry PCB's on the rear side and should be handled carefully in order not to be stressed.

(f) Please contact SEC in advance when you display the same pattern for a long time.

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